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# MEASURING DEVICE FOR MEASURING HARVESTED CROP THROUGHPUT IN AN AGRICULTURAL HARVESTING MACHINE

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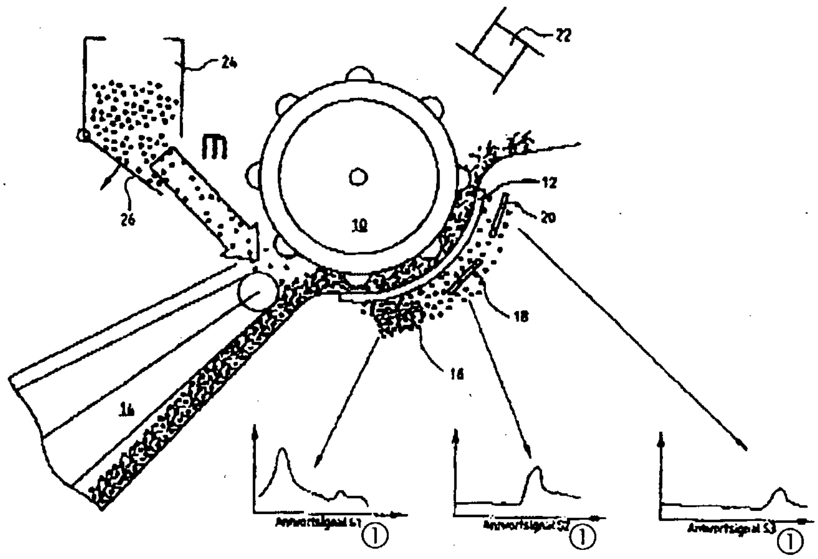


Key: 1 Response signal

The invention relates to a measuring device for measuring the throughput of harvested crops in an agricultural harvesting machine, with at least one sensor designed to measure the intensity of a flow of harvested material.

When combine harvesters are used in farming, the grain loss that occurs is a significant process factor since this loss is a decisive evaluating factor for the driver when selecting the travel speed and adjusting the parameters of the threshing process. The problem lies in the imprecise determination of this loss.

Devices for measuring grain loss are currently installed in almost all combine harvesters. However, their accuracy is deficient. There has been no satisfactory technical solution up to the present for a long-lasting and sufficiently accurate determination.

The known measuring devices for grain losses generally consist of several grain sensors that are arranged below the working parts such as threshing drums, shakers, sieves, etc., and that furnish signals when grain strikes. The more frequently the grain strikes, the higher the grain losses.

However, it cannot be precisely determined which portion of the grains that are collectively present in the crop flow is measured and how many grains furnish a direct electric impulse and which portion is not measured, since it does not initiate an electric impulse. The result can be additionally falsified by straw nodes, that also initiate electric impulses.

It has been determined that all previous solutions therefore contain the same system-conditioned measurement errors. The impulse frequency is a direct function only of the amount of grain in the lowest layer of the straw mat and is additionally influenced by changing harvesting conditions. What amount of grain is present in the layers above this lower layer

cannot be determined. In the case of unfavorable separating conditions the ratio between impulse-initiating grain and the total grain loss in the straw mat located above the impulse-initiating grain is smaller than under more favorable conditions. As long as the quantitative distribution of grain in the straw mat located above the impulse-initiating grain cannot be determined, no exact measurement of losses is given by the sensor systems measuring on the bottom of the straw mat. Arranging of sensors directly in the crop flow of the combine harvester and/or an identification of grain in the straw mat with physical measuring principles is not possible.

It appears obvious, e.g., to use several sensors for determining the characteristic separating line. However, the occurrence of the above-cited error in all sensors is again a disadvantage, so that the measuring accuracy could not be substantially increased. The quantitative distribution of grain and the straw mat continues to be unknown.

Measuring devices that detect the throughput of harvested crop and that have erroneous measured values are also located at other positions in harvesting machines, especially in combine harvesters. In order to reduce measuring errors US 5,369,603 teaches calibrating an impact plate sensor with test runs in which the mass of the harvested grain tank content is measured by weighing. DE 195 41 177 A suggests measuring the crop flow continuously with a first measuring device. The crop flow is subsequently transported into a second measuring device whose measured value is used to calibrate the first measuring device. According to both publications a measured value is first detected with a first sensor and the measured value of the first sensor is subsequently calibrated with a second sensor. However, two sensors are required for this.

The invention has the basic problem of developing an improved measuring device for the precise determination of a crop throughput.

The invention makes this possible by an additional supply, carried out upstream from the sensor, of a defined amount of grain that has already been harvested and thus has the same material properties. This grain can bring about an undesired, greater loss of grain but makes it possible to determine the error of the sensors. The dosing can take place in a time-controlled manner at one or several points. The crop throughput can be mathematically exactly determined from the effect, e.g., of additional impulses on the sensors or a step response function, given a known added amount of grain.

The sensor is preferably arranged on the discharge side of a crop processing device that separates grain. Then the quantitative distribution of grain in the straw mat and therewith the grain losses can be totally calculated. The dosed supplying of additional grain into the grain separating process, which is defined locally and in time, yields clear conclusions about the quantitative distribution of grain in the straw mat. The precise determination of grain loss can be

made therewith. However it is also conceivable that the sensor is a crop throughput sensor (in particular an impact plate or optical sensor) arranged, e.g., in a grain elevator. The changing of the measured value of the crop throughput sensor brought about by the addition of additional crop by the dosing device serves to calibrate the sensor.

According to the invention the influence of the various material properties of the harvested crops can be quantified and taken into consideration during the determination of the separating losses and of the degree of separation and/or of the regulating of all of the threshing and separating devices.

The supplying of the crop necessary for determination takes place via one or several grain dosing devices that are used in addition to the known sensors for grain losses.

This device doses a defined mass of harvested crop (here: grain) as an addition into or onto the crop flow. As a consequence of supplying an additional, defined amount of crop the signals that change thereupon can be better interpreted at the sensors and conclusions about the actual separating behavior of the threshing and separating devices can be better made than was previously the case. The amount of selected crop is a function of the throughput. It must on the one hand be sufficiently large in order to obtain a response signal. On the other hand the duration as well as the amount of the supply of mass should be held as small as possible in order to minimize the impairing of the separating process. The supply of crop with the aid of grain dosing devices can take place continuously, can be limited in time or can take place at regular intervals over the entire width of the threshing and separating devices or can be locally limited. The use of the grain dosing device can take place in combination with grain sensors at every point of the crop flow, e.g., in front of the threshing drum, the shaker, sieves or the turnover.

The quantitative characterization creates new possibilities for automation in the combine harvester. The utilization of the performance of the combine harvester by the driver of by automation systems can be substantially improved. The deficiency of previous solutions of not considering the quantitative distribution of grain during use under conditions of practice is eliminated by the purposeful external influencing of the separating process in order to achieve a process analysis in the combine harvester.

An exemplary embodiment of the invention is shown in the drawings and described in detail below.

Figure 1 shows a threshing device of a combine harvester with a measuring device in accordance with the invention.

Figure 2 shows a separating device of a combine harvester with a measuring device in accordance with the invention.

Figure 1 shows the threshing device of a combine harvester. It comprises a rotatably arranged threshing drum 10 in a known manner. Threshing concave 12 is arranged on a part of

the circumference of threshing drum 10. Threshing drum 10 is supplied by oblique conveyor 14 with a crop flow from a crop recovery device, as a rule a cutting mechanism. Threshing drum 10 provided with threshing strips threshes the crop and loosens grain out of it that falls down through openings in threshing concave 12. Three sensors 16, 18, 20, which can be known impact plate sensors, are arranged in series below the threshing concave. Guide drum 22, that supplies the threshed crop to a separating device (Figure 2), follows downstream from the threshing drum.

Dosing device 24 is filled with grain supplied to it, e.g., by an appropriate line from the grain tank of the combine harvester. Dosing device 24 is provided on the bottom with flap 26 that can be folded open. When flap 26 is opened, a defined amount of additional grain passes into the crop flow supplied to threshing drum 10. Sensors 16, 18, 20 then furnish the signals shown in the lower part of Figure 1. When grain is added from dosing device 24 a signal rise is obtained. A corrected throughput of grain in threshing drum 10 is calculated by an evaluation device from the original signal and from the signal changed by the defined addition of grain.

Figure 2 shows the separating device of a combine harvester 10. It consists of a known straw shaker 30. Three sensors 32, 34, 36 with a known construction, e.g., impact plate sensors, are arranged below straw shaker 30. They detect the amount of grain falling down from straw shaker 30. A second dosing device 38 is filled with grain supplied to it, e.g., by an appropriate line from the grain tank. Dosing device 38 is provided on the bottom with flap 40 that can be opened. When flap 40 is opened, a defined amount of additional grain passes into the crop flow supplied to straw shaker 30. Sensors 32, 34, 36 then furnish the signals shown in the lower part of Figure 2. When grain is added from dosing device 38, a signal rise is obtained. A corrected throughput of grain in straw shaker 30 is calculated by an evaluation device using the original signal and the signals changed by the defined addition of grain.

Such a dosing device can also be arranged at the inlet of a sieve device below which device one or several sensors for detecting the separated grain is/are attached that are connected to an evaluation device designed in the manner described above. In all embodiments described the evaluation device connected to the sensors can be connected to a display device that displays the grain throughput and/or the grain losses to the operator. The signals made available by the evaluation device can also be used for automatically adjusting work parameters of the harvesting machine (e.g., travel speed, adjustment of the threshing drum, sieve apparatus opening and air-blast velocity in the sieve) and/or for geo-referenced yield mapping.

## Claims

1. A measuring device for measuring the throughput of harvested crops in an agricultural harvesting machine, with at least one sensor (16,18,20,32,34,36) designed to measure the

intensity of a flow of harvested material, characterized in that a dosing device (24,38) is present with which a certain amount of crop can be additionally supplied to the flow of harvested crop.

2. The measuring device according to Claim 1, characterized in that the sensor (16,18,20,32,34,36) is arranged at the output side of a crop processing device that separates grains and that said sensor detects an amount of separated grain.

3. The measuring device according to Claim 2, characterized in that the crop processing device is a threshing device, in particular a threshing drum (10) and/or a separating device, in particular a straw shaker (30) and/or a cleaning device, in particular a sieve.

4. The measuring device according to Claim 2 or 3, characterized in that the dosing device (24,38) is arranged so that it loads the crop processing device with harvested crop.

5. The measuring device according to one of the preceding claims, characterized in that the sensor is a crop throughput sensor that is associated with a conduit in which crop is transported, e.g., a grain elevator and that can be loaded with additional crop by the dosing device.

6. The measuring device according to one of the preceding claims, characterized in that the supplying of the additional crop with one or several dosing devices (24,38) takes place into or onto the flow of harvested crop.

7. The measuring device according to one of the preceding claims, characterized in that the crop is supplied continuously or discontinuously onto the entire width or onto a partial width of the crop processing device.

8. The measuring device according to one of the preceding claims, characterized in that an evaluation device is set up to calculate an error-corrected measured value using the measured values of the sensor (16,18,20,32,34,36) during an addition of additional harvested crop and during the absence of an addition of additional harvested crop.

9. A harvesting machine, in particular a combine harvester, with a measuring device in accordance with one of the preceding claims.

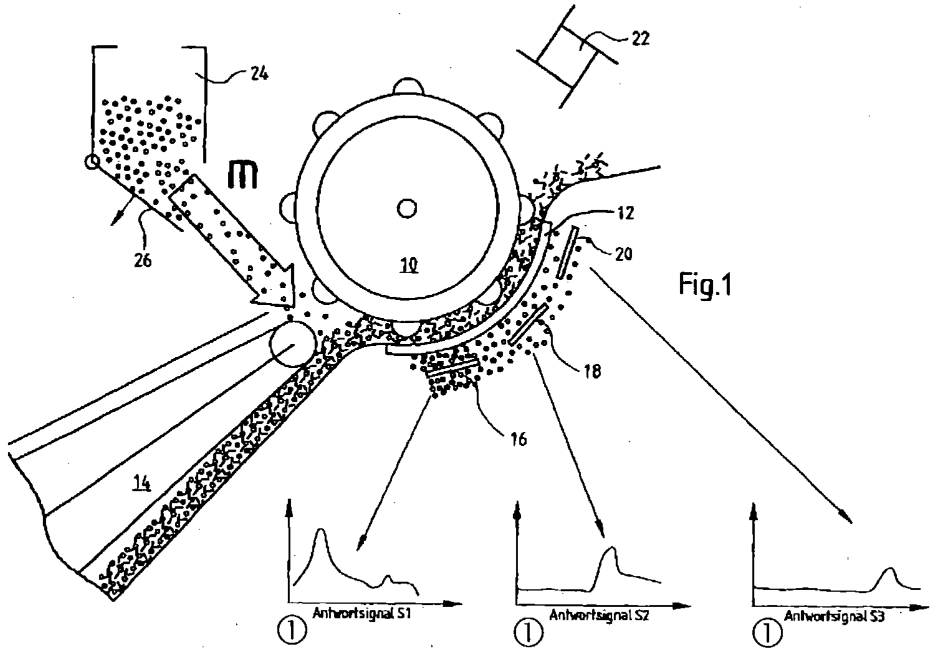


Fig.1

Key: 1 Response signal

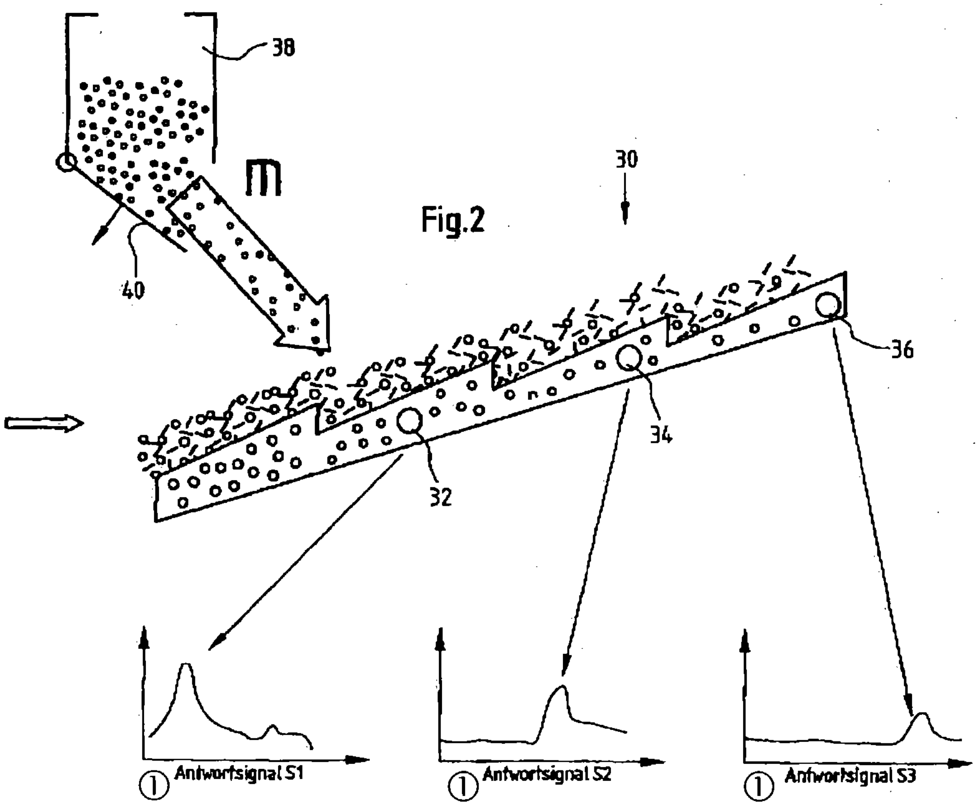


Fig.2

Key: 1 Response signal

# INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 02/00896

**A. CLASSIFICATION OF SUBJECT MATTER**
IPC 7 A01D41/12

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 A01D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category * | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| A | DE 43 20 977 A (MAEHDRESCHERWERKE AG) 5 January 1995 (1995-01-05) column 2, line 29 - line 50 ----- | 1 |
| A | DE 199 21 466 A (DEERE & CO) 9 November 2000 (2000-11-09) column 5, line 19 -column 7, line 1; claims 1,7,11 ----- | 1,5-7,9 |
| A | US 5 351 558 A (HORN KLAUS ET AL) 4 October 1994 (1994-10-04) ----- | |
| A | GB 1 203 134 A (FEIFFER) 26 August 1970 (1970-08-26) ----- | |
| A | DE 40 35 471 A (SAECHSISCHE MAEHDRESCHERWERKE) 29 May 1991 (1991-05-29) ----- | |
| | -/-- | |

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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| Date of the actual completion of the international search | Date of mailing of the international search report |
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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/EP 02/00896

| Patent document cited in search report | | Publication date | Patent family member(s) | | Publication date |
|---|---|---|---|---|---|
| DE 4320977 | A | 05-01-1995 | DE | 4320977 A1 | 05-01-1995 |
| DE 19921466 | A | 09-11-2000 | DE | 19921466 A1 | 09-11-2000 |
| | | | BR | 0002403 A | 02-01-2001 |
| | | | CA | 2308733 A1 | 08-11-2000 |
| | | | EP | 1051898 A2 | 15-11-2000 |
| | | | US | 6315658 B1 | 13-11-2001 |
| US 5351558 | A | 04-10-1994 | DE | 4105857 A1 | 27-08-1992 |
| | | | DE | 4227922 A1 | 24-02-1994 |
| | | | DE | 59200669 D1 | 01-12-1994 |
| | | | DK | 501099 T3 | 03-04-1995 |
| | | | EP | 0501099 A1 | 02-09-1992 |
| | | | RU | 2044277 C1 | 20-09-1995 |
| GB 1203134 | A | 26-08-1970 | NONE | | |
| DE 4035471 | A | 29-05-1991 | DD | 289685 A5 | 08-05-1991 |
| | | | DE | 4035471 A1 | 29-05-1991 |
| DE 2009860 | A | 21-01-1971 | DE | 2009860 A1 | 21-01-1971 |

# INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 02/00896

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

| Category * | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
| --- | --- | --- |
| A | DE 20 09 860 A (KÜHN)<br>21 January 1971 (1971-01-21) | |